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Some Aspects of the Plant Disease Eradication and Control Work of the Bureau of Entomology and Plant Quarantine

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOME ASPECTS OF THE PLANT DISEASE ERADICATION AND CONTROL WORK OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Papers by members of the Bureau of Entomology and Plant Quarantine.

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THE DUTCH ELM DISEASE ERADICATION PROGRAM— OBJECTIVE, METHODS, AND RESULTS

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Statement of Principles

The immediate control and ultimate eradication of the disease from the United States is the objective of the Dutch elm disease program. In the major area around New York City, where the disease has reached an epidemic form, control is a necessary prerequisite to ultimate eradication. In areas where the disease is largely limited to primary infections eradication methods are immediately applicable.

Definite checking of the spread of the disease within and from the infected area and a reduction in the amount of the disease may constitute control. This condition may be secured by a general and large-scale field operation over the entire area, provided the efforts are timely and uninterrupted. Following control, eradication may require specialized treatment of a number of small disease centers within the original large area. The justification for this objective, the methods of control and eradication, and the evaluation of the results are based upon the nature of the disease and its insect carriers. Data on these subjects have been secured by fundamental research in combination with field tests and observations.

The Disease and Insect Vectors

Many reports on the status of the Dutch elm disease in Europe indicate that the epidemic has spread over all but the northern countries and that it has continued its ravages throughout the disease area. Field observations and research tests, made in Europe, early showed that the American elm, Ulmus americana, is one of the most susceptible elm species. The Scolytus bark beetles are recognized as the principal vectors of the disease. Various attempts to prevent infection and to cure diseased trees have been made but no successful treatment has been found. On these bases the eradication of the disease as the only assurance of saving the elms in America was early decided upon.

In America the Dutch elm disease epidemic is limited to a small area centering on New York City, extending about 50 miles radially, and comprising about 4,800 square miles, where about 22,000 diseased trees have been found. The intensity of the disease has reached as high as 100 trees per square mile or 10 percent of the elms in certain small centers within the major disease area. However, near the 50-mile limits the known disease locations may be 5 to 10 miles apart and contain only 1 to 5 trees at each point.

Diseased and Scolytus-infested elm burl logs from Europe entered this country as early as 1925 and continued to enter until 1934. During this period 11 shipments entered at New York City, 22 at Baltimore, 9 at Norfolk, and 16 at New Orleans. In general these logs were loaded on freight cars and shipped to veneer factories in the Central or Midwest States. Seven small disease centers in addition to the major New Jersey-New York area are traceable to these logs. There is now an embargo against elm material.

The Dutch elm disease is a systemic disease characterized by the formation of gums and tyloses in the water vessels of the current year's wood. The fungus, Ceratostomella ulmi, once gaining entrance to the active vascular system, may spread rapidly in the water stream upward and by gravity downward. Although of limited growth as a parasite, it maintains itself and sporulates abundantly on dead wood and bark. The limited growth and apparent lack of surface fruiting on living material is a distinct advantage to the eradication program. Except when introduced into wood already dead, conspicuous disease symptoms develop before a dangerous supply of inoculum is produced.

Insects that penetrate to the living wood of elms may be considered important vectors of the Dutch elm disease. The bark beetles that, upon emerging from fungus-bearing material, attack through the bark are consequently the most successful vectors. Scolytus multistriatus, the small European elm bark beetle, and Hylurgopinus rufipes, the American elm bark beetle, are considered the two important disease vectors in America. The Scolytus beetle has become established in three areas in the United States. The Boston infestation probably originated several years before it was reported in 1909. The New Jersey-New York infestation was not reported until 1924, but field conditions indicate that this infestation is as old as the Boston center. The third center, in the upper Ohio River Valley, apparently started from elm burl logs sometime after 1925.

Only in the New Jersey-New York area have the Dutch elm disease and this insect become definitely associated. Nevertheless, the presence of this important vector in two other important elm areas, New England and Central States, adds materially to the need for immediate action. H. rufipes, with habits somewhat similar to those of Scolytus, is distributed throughout the entire elm area in America. Not only is Hylurgopinus an important vector but it may serve as a bridge for the disease, between the major disease area and the other two Scolytus areas. In contrast to the absence of Scolytus, Hylurgopinus has been found in all of the outside disease areas.

Location and Removal of Diseased Trees

The timely location and prompt removal of all Dutch elm disease trees is a necessary step toward control and eradication. In general, this project consists of three essential parts; (1) locating and sampling of wilted and dying elms, (2) mapping of elm-free areas and scattered elms, and (3) locating and tagging of devitalized elms. This survey at the present time includes (1) about 4,800 square miles of disease area all within 50 miles of New York City, (2) about 2,700 square miles in a protective zone around this area, (3) sixteen outside areas, principally port cities and Midwest cities that handled imported logs, and (4) about 12,000 miles of railroad that hauled these logs.

The nature of the disease, especially the development of external symptoms early in the course of the disease, makes the systematic examination of all elms an effective means of locating a large percentage of the trees. Evident wilting and dying of a branch or an entire tree may occur any time after the last of May and until the first of September. As these external symptoms of the Dutch elm disease are more acute in the early summer, the most effective scouting can be done in June and July. Those trees in which the disease appears in a chronic form and those in which the Dutch elm disease symptoms are masked by the effects of drought, other diseases, insect attack, or unfavorable soil conditions, create special scouting problems. One of the most effective means of eliminating these chronic and masked trees is the systematic removal of all dead and devitalized elms. As these trees can be more effectively detected during the foliar season, the locating and tagging of such trees forms a part of the scouting work in August and September.

In rough undeveloped areas where the scattered wild elms have been removed, the remaining elms along roads and around farm homes may be reached by a combination of foot and auto scouting. In developed rural sections and urban areas scouting must be done entirely on foot. The autogiro has been found effective in locating diseased elms in undeveloped areas.

The effectiveness of the scouting work is dependent largely upon the location and removal of diseased trees before elm bark beetles emerge from them. From the time of first wilting and concurrent beetle attack there is, in general, a 40-day period before beetle emergence begins. Providing the tree is located promptly, and allowing 7 days for laboratory diagnosis, 10 days for obtaining clearance from property owner, and then two weeks for final removal, the entire operation may be completed 10 days before the time when beetles would emerge. In general, during this maximum period of 30 days, from the time of first wilting until removal, the tree has not become a menace as a source of disease spread. This delay in becoming a menace adds materially to the effectiveness and probable success of the eradication program.

The degree of thoroughness and timeliness with which the scouting program can be completed is influenced by (1) the number and quality of scouts employed, (2) the time of the year when their services are available, (3) the equipment necessary for efficient work, and (4) the degree of cooperation of the States in which the work is done. The extra work of removing the large number of diseased trees that had accumulated before the work began, the task of locating or creating and mapping elm-free and scattered elm areas and the job of developing trained scouts and scouting equipment have added to the cost of the program during the first few years.

Owing to the type of scouts employed, the amount and quality of work have not been up to the standards set for the program. Another unfortunate circumstance has been the seemingly recurrent impossibility of having a full force at work in June and July, the critical period of the summer work. In general, the removal of diseased trees within the time limits described has been successfully completed in both 1935 and 1936. The tools required for scouting and tree removal have at certain periods been somewhat limited.

The results of the scouting program may be determined by comparing the field conditions in 1933 with those observed in 1936. In 1933 and 1934, scouting was concentrated in the urban areas within the heavily infected zone and these areas again received good attention in 1935 and 1936. In contrast to 1933 and 1934, most of the diseased trees were located and removed in 1935 and 1936 before a brood of disease-carrying beetles had emerged. Based on the number of diseased trees found and the general field observations, there has been a striking decrease in the intensity of the disease and local spread has been definitely checked in these urban areas.

Only during the last two years, and principally in 1936, have the undeveloped portions of the disease area and the protective zone been scouted with any degree of thoroughness. Consequently, a satisfactory reduction has not been made and the work has only been able to hold the disease in check in the undeveloped areas. At the outer limits of the disease area and in the protective zone, some additional diseased trees were found in 1936. Examination of these trees showed, however, that they were not current infections in most instances but largely older infections not found until 1936. In this area in general there was no recurrence of the disease in areas where it had been found in 1934 or in 1935. Furthermore, with but one exception, the new locations are within the 50-mile limits of the disease. Apparently the work in the heavily diseased area has effectively reduced or stopped the spread of the disease into these outer areas.

In the disease centers outside the major disease area, scouting did not uncover a single tree that had become diseased in 1936. With but one exception, those trees that were found showed evidence of having been infected from the original source of inoculum from imported logs. In Indianapolis a disease center containing 11 diseased trees which apparently resulted from secondary spread in 1934 and 1935 was not found until 1936. There was no recurrence of the disease found at Cincinnati, Cleveland, and Brunswick, Maryland. There was found one diseased tree at Baltimore, one at Cumberland, Maryland, and one at Norfolk, Virginia, all three trees being of older infection and none having produced disease-carrying beetles. Thorough scouting and special sanitation work have resulted in the apparent eradication of the Dutch elm disease at Old Lyme, Connecticut. In general, eradication has been effected or is unquestionably within reach in these outside areas. The scouting of the 12,000 miles of railroads that carried imported logs has not been satisfactorily completed. The negative results of the preliminary survey that has been made are considered satisfactory evidence that no serious disease center has escaped detection.

Sanitation and Silvicide Work

Field observations supplemented by laboratory tests indicate that dead and dying or devitalized elms may harbor Ceratostomella ulmi either as a saprophyte in the dead wood or as a parasite producing a chronic disease form. In certain areas of the heavily infected zone from 3 to 30 percent of this class of trees produced C. ulmi in culture. As a step toward eradication these trees, as a class, have been condemned and removed. In addition to these devitalized elms there are a large number of wild and worthless elms in many of the wooded and swampy areas. Owing to disturbance resulting from varied land uses in the large metropolitan area, many of these elms are in a declining condition. In the mountainous areas, where the elms are of very minor importance, by removing from 5 to 10 percent of the total elms and leaving only the valuable shade and roadside elms, a large portion of the area may be made elm free. Inasmuch as a large part of the protective zone is made up of this type of terrain, the elm-free areas may tend to serve as a barrier to the disease.

The removal of devitalized elms was started during the 1933-34 winter and was emphasized during the last two winters. At the end of the present work period about one and three-quarter million elms have been removed. Another three-quarter million are scheduled for removal during the remainder of the winter season. When these are disposed of, practically all elms more than 50 percent dead will have been removed from the entire major disease area. In addition to these elms about half a million elms have been removed from swamp areas in clear-cutting operations in New Jersey. The attack on the worthless woodland elms only began in the fall of 1936. A rapid method of killing these trees and rendering them harmless by a chemical treatment has made it possible to handle about half a million woodland trees, principally in New Jersey, during the last three months.

In contrast to the extreme difficulties encountered in securing and training an adequate scouting force, personnel problems on the sanitation project have not been so troublesome. A large percentage of the field force consists of laborers; and those in relief, except in strictly city areas, are able to do an acceptable job. Furthermore, the supervisors and higher grade scouts used during the summer work are able to do the skilled work and to supervise the labor crews. One disconcerting feature, however, has been the inability to keep the project going without interruptions and temporary lay-offs during the winter. During the last two winters a field force of 3,000 to 5,000 has been employed in sanitation work. In addition to this force, men from six CCC camps have been employed satisfactorily on this sanitation project the last 2 years.

The equipment problem has caused some inefficiency in the work, but at the present time the field force is reasonably well equipped. Because of the low quality of some of the tools, especially axes and saws, large replacements will be required before the work is completed. Although many new cars and trucks have been purchased during the last two years, it still is necessary to use many obsolete pieces and to hire, at high rental, additional trucks. When this condition is corrected, the efficiency of the sanitation crews as well as the summer scouts will be materially advanced. The use of power equipment, caterpillar tractors, and pneumatic driven chain saws has increased the production of the crews so equipped.

The chemical treatment of trees, popularly called silvicide, has been emphasized this winter. It consists of removing the bark around the trunk about breast high and applying a band of copper sulphate. The chemical is held in place by a band of oil cloth securely nailed on and sealed to prevent washing by rain water running down the trunk. The copper sulphate, comparable to granulated sugar in fineness, is used in the dry form. The moisture in the wood during the winter season is sufficient to bring the copper slowly into solution. Field observations indicate that the copper readily moves down through the trunk and into the roots. Previous experience with stumps shows that the root system may be killed in this manner. During the winter season the upward movement is somewhat limited, but during the foliar season the copper may move rapidly upward to the small twigs. Inasmuch as the chemical is concentrated in the outer annual ring and cambial region it may act as an insecticide or repellent to the bark beetles.

Confirmed Dutch elm disease trees and those with appreciable amounts of dead or beetle-infested wood are not so treated, but are promptly disposed of by cutting and burning. The large project of treating or removing scattered elms from mountainous areas, particularly in the protective zone, has not been started. It is proposed to carry on this work during the summer season in connection with scouting.

It must be noted that only devitalized or diseased and worthless wild elms are involved in the sanitation project. Excepting those valuable elms that have been or may in the future be destroyed because of actual attack by the Dutch elm disease, no valuable elms are condemned. Analysis of the field reports in 1934-35 indicate that about 80 percent of the elms removed were less than 4 inches in diameter. The removal of large dead and dying elms, especially lawn and street trees, is a definite asset to the property owner. The low vitality of many elms in certain swamp and artificial water supply areas is considered evidence that under these conditions elms are not a desirable species, and so their removal or treatment may be considered a good forestry practice.

Discussion

In conclusion, certain general summary statements of the accomplishments to date and limited estimates of the future of the project may be made. At the start of the major eradication program in 1933 the question "Can the Dutch elm disease be eradicated in the United States?" could not be answered. It was believed that a delay of field operations, while awaiting the answer, would be not only undesirable but fatal to the elms. It was believed then that the results of one year's work in which the field operations were timely and thorough, would provide the answer. Unfortunately, it has been impossible to reach this standard of operation during any one year since 1933 to the present time. However, the accumulative effects of several years of work in the entire disease area and the local effects of the work in certain small areas where the operations have been timely and complete in 1935 and 1936 may be significant. It is thus possible at this time to present data that will probably answer the question "Can the Dutch elm disease be eradicated?"

As previously indicated, control of the disease must prevent spread within and from the area and must reduce the number of diseased trees until the major disease area consists only of several small separate centers. This condition has been attained in several parts of the major disease areas that have received adequate attention. The number of diseased trees found in certain areas in 1934, 1935, and 1936, respectively, may illustrate this point.

	1934	1935	1936
Staten Island, N. Y.	671	327	69
Queens County, N. Y.	54	16	6
Mamaroneck, N. Y.	110	54	25
Mt. Vernon, N. Y.	78	32	15
Irvington, N. J.	57	14	3
Orange, N. J.	98	13	4
Roselle, N. J.	14	5	1
Hillside, N. J.	33	16	4

In areas where spread has been stopped and the backlog of disease has been materially reduced the situation is comparable to that in areas where the number of diseased trees is small and spread has never occurred. Thus the remaining centers within the former major disease area may be eradicated by the same methods found successful in the small outside centers where eradication has been effected or is at hand. There may be mentioned specifically, Cincinnati where the first tree was found in 1930, Old Lyme, Connecticut, where a definite threat to New England existed in 1934, and Cleveland, Ohio, where no disease was found in 1936. In fact, satisfactory results toward eradication have been realized in all outside areas, except at Indianapolis, where the program was not thorough in 1935.

Therefore, the question of eradication may be answered affirmatively on the basis of actual control in heavily diseased areas at the present time and satisfactory evidence of eradication in the smaller disease centers. Believing that the disease can be eradicated, the reaching of this objective then depends on the uninterrupted attack, by methods that have proven satisfactory, through years immediately ahead on an adequate and timely basis.

WHITE PINE BLISTER RUST CONTROL AND BARBERRY ERADICATION IN 1936

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PROGRESS IN BLISTER RUST CONTROL

There are in the United States about 15,000,000 acres of forest land on which five-leafed pines of commercial value and quality are now growing. If this entire 15,000,000 acres is to be protected from blister rust infection, it will be necessary to remove the currant and gooseberry plants not only from among the trees but also for a distance of some 900 feet from the stands. These surrounding protective zones increase the acreage to be covered to about 26,000,000 acres of land. The status of the program at the present time is that over two-thirds of these 26,000,000 acres, approximately 18,000,000 acres, have been covered and the Ribes removed at least once.

During the past summer, as a measure of unemployment relief, Ribes-eradication crews totalling about 14,000 men have been maintained in the field in 29 States. These crews have removed the Ribes from 3,829,890 acres, covering the ground at the rate of approximately 3.6 acres per man-day. In this work about 196,211,187 Ribes have been destroyed during the past summer. In terms of pine this presumably represents the protection of between 100,000,000 and 200,000,000 pine trees this season.

It was about 1918 when the foresters and forest pathologists of the country faced the fact that white pine blister rust (Cronartium ribicola) was established in the United States beyond the possibility of total eradication and could only be prevented from destroying one of America's most valuable forest trees by covering the woods foot by foot and acre by acre to eliminate the currant and gooseberry plants. It is probable that the most common mental reservation as to the practicability of such an undertaking related to the extensive areas and tremendous numbers of plants involved. This sometimes found expression with respect to the Rocky Mountain regions in the thought that covering these vast, apparently trackless areas and attempting to destroy wild Ribes throughout them seemed to be an inconceivably hopeless undertaking. One has only to climb one of the fire towers in the vicinity of the Bitterroot Mountains or in the Sierra Nevadas and survey from there the stands of Western white pine or of sugar pine to be impressed with that point of view.

Fortunately, however, it was not necessary to undertake white pine blister rust control with the expectation that the whole job would have to be completed, that is that 100 percent of the pine stands should be covered or the work would be valueless. On the other hand, in the case of this project each separate stand, or square mile, or township, or county, of white pine is a separate project of its own. The elimination of the Ribes in and around such a stand or area and the maintenance of Ribes-free conditions there means the protection of that tract regardless of what may happen to the surrounding stands or to the rest of the country as a whole. As soon as the foresters convinced themselves that Ribes eradication could be carried out at a cost which the value of the trees would later repay, and that such costs were only a small proportion of the expense of letting the forest go down with disease and then replanting with some other species, a foundation was laid for undertaking to protect as large a proportion of the country's pine stands as possible.

In the industrial and commercial development of the United States, labor has always been the scarcest and most costly factor in production. Ribes eradication in the pine forests could not be carried out without the use of large numbers of laborers because there is no way of developing machines which will distinguish Ribes from other plants and remove them alone. The unemployment problem developing since 1930 has resulted in making much more labor available for conservation and other public purposes. In 1933 this situation was officially recognized by the Federal Government, and the resources of the United States were thrown into the attempt to find ways of employing the available labor along lines that would give results of benefit to the public as a whole. We find, accordingly, that under these emergency employment relief programs it has been possible to employ, on white pine blister rust control, men whose labor has now totaled 3,228,342 man-days since 1933, and their work has resulted in the eradication of Ribes and of the protection of pine on 10,571,775 acres of land.

The Public Works Administration allotment to Blister Rust Control for 1933 to 1935 totaled $2,032,030, and the allotments from the Emergency Relief Appropriation Acts of 1935 and 1936 have amounted to $6,907,804 for this purpose to date.

You will be interested in learning that relief laborers have proved surprisingly effective for employment even on such work as cultivated black currant eradication and pre-eradication surveys. It was at first believed that it would be necessary to use the college-trained type of employee for work of this kind which, in the case of black currant eradication, involves interviews with house-wives and property owners and, in the case of pre-eradication surveys, ability to determine and locate the boundaries of white pine stands and to map the stands and the 900-foot borders by the use of compass and pacing. It may be that under ordinary employment conditions the ranks of the unemployed would not include men who could be trained to carry out activities of these types, but, during the past two years at least, it has been possible to choose from among the men assigned to us those who had sufficient ability, initiative, and personality to carry out work of this type satisfactorily. They need, of course, adequate and carefully trained supervisors who keep in touch with them at all times, but with such trained supervision they are accomplishing excellent results. Much of the special work of this kind, particularly of the pre-eradication survey type, is being carried on throughout the winter, although Ribes eradication in the forests cannot be carried out efficiently after the leaves have dropped. Even on this kind of winter work it is being found practicable to maintain the ratio required by the Works Progress Administration, namely, nine relief laborers to each regularly appointed supervisor.

Spread of Infection

Now, as to the status of infection at the present time. The rust has been well established for several years in New England and in the Lake States, and has been spreading steadily southward into the Southern Appalachians in the East. In this region it was found in 1935 as far south as Bath and Nelson Counties, Virginia, and infected Ribes leaves were picked up in northern Illinois and Indiana. No spread of infection has been reported this season in the Appalachian section and no rust was discovered in 1936 in Illinois and Indiana.

The North Central Region leads in the number of newly infected counties reported in 1936. Blister rust was found on white pine for the first time in 10 counties in Wisconsin: Buffalo, Eau Claire, Winnebago, Rusk, Door, Vilas, Price, Langlade, Outagamie, and Waushara; 3 counties in Michigan: Schoolcraft, Saginaw, and St. Clair; and 1 in Minnesota: Todd.

Infection was found for the first time on Ribes in Winnebago and Sauk Counties, Wisconsin; Koochiching County, Minnesota; and Knox County, Ohio. These findings materially extend the known range of infection in the Lake States.

With respect to the western white pine region in the Pacific Northwest, an area in which some 2,700,000 acres are producing pine, it was originally thought, after observing the rapidity with which infection developed in certain localities, that 1935 or 1936 would be approximately the dead-line for the protection of those stands, and that any pine stands which had not yet been reached by that time would be so heavily infected as to be beyond saving. This original estimate did not prove to be so far wrong, for the summer of 1935 ultimately proved to be the year that the upland species of Ribes first became widely and generally infected throughout the region. The results of this infection in the development of pine cankers will not be fully ascertainable for another year or so, owing to the slow incubation period in the pine trees, but by 1935 approximately half of the entire 2,700,000 acres of western white pine area of the Northwest had already been covered in initial Ribes eradication work. Another 300,000 acres have been covered in the Northwest this year, and it now seems clear that if the work can be carried forward vigorously most of the remaining 35 to 40 percent can be protected from serious damage.

Blister rust has been found this year (1936) for the first time in California. Five locations are involved in that State, all in the two northwest counties, Del Norte and Siskiyou. Three of these cases are on Ribes only, one on pine only, and one on both hosts. The high susceptibility of sugar pine (Pinus lambertiana) was determined in experimental tests in British Columbia a number of years ago, but the recent discovery of a serious infection center on this species on Panther Mountain in southwestern Oregon constituted the first illustration of what infection on this species actually does in nature. Confirming the experimental work, this area has been about as rapidly disastrous a case of blister rust infection as has been observed anywhere in the United States. The site, although in the coastal fog belt, is a typical dry sugar pine area in which the pine is associated with Ribes cruentum, a prickly gooseberry very similar to the one common in the Sierra Nevada Mountains, Ribes roezli. Judging from the available evidence, it appears that the rust has been developing on the pine in this quite remote and inaccessible locality since about 1926, and during the 10-year period practically 100 percent of the pines of the locality have become infected. Trees up to 6 or 8 inches in diameter and 50 to 70 years in age have already been killed as a result. The rust is attacking the sugar pine there in the same manner that it kills western white pine (P. monticola), that is, through the development of cankers on such a large number of lateral branches that starvation of the tree follows,

and death results from that cause. This, you will remember, distinguishes the western infection from the typical situation on the eastern white pine (P. strobus), where the death of the tree usually comes much more slowly, from cankers reaching the trunks and girdling the trees.

Fortunately, it was possible to start the protection of the sugar pine region before the rust actually was discovered in California. Of the 2,004,330 acres of sugar pine in the State, some 428,131, or about 21 percent, have now been covered at least once by Ribes eradication.

One of the interesting studies of the past few months has been a joint attempt by our Bureau and the Forest Service to evaluate the potential future production of 5-leafed pines in the west. It would take too much time to go into the details here, but the conclusions may be expressed briefly. It is estimated that on the western control areas of about 5,000,000 acres the future timber maturing after the virgin stand is cut should average 822,000,000 board feet a year, having a stumpage value of $7,400,000 and an annual lumber value of $46,640,000. Over a rotation period of 120 years the lumber value of the aggregate potential crop is estimated at $5,500,000,000.

European Black Currant Eradication

Among the phases of blister rust control carried on by the division and the cooperating States in addition to Ribes eradication within the pine forests, the most important is the eradication of the cultivated European black currant (Ribes nigrum). Several species of black currants are much more highly susceptible to blister rust than are other Ribes, and they produce such volumes of spores that they are able in appreciable and damaging numbers to reach distances of a mile or more from the Ribes. Accordingly most of the States in which white pines are commercially important have undertaken the complete extermination of these species. The only one of this group occurring in the Eastern half of the United States is the cultivated European black currant. At the present time the Lake States are most busily engaged in European black currant eradication, this work having been substantially completed in the Northeastern States and on the Pacific Coast several years ago. In the Lake States region 85,385 cultivated black currants were destroyed during 1936 on 13,374 properties.

Cooperation

No information is available at the present time as to the possibility of further unemployment relief allotments being granted after the present emergency funds are exhausted this winter. Accordingly our cooperators in the various States have been notified that future plans are being

made in the Bureau with the expectation of returning to the former basis of cooperation in use before the emergency programs started. Under this system the United States Department of Agriculture cooperated with the various States on approximately a dollar-per-dollar basis. The Federal funds were used for the maintenance of an organization for supervision, coordination, method development, educational activities, and similar matters. All the work on private property was carried out with labor supplied by the States, towns, or private owners. The exact arrangements differed in the various States, one plan, for example, being for the State to pay the wages of the individual foreman, who would then work with crew members supplied by the individual property owner. In other cases where pine land covers considerable areas involving large numbers of property owners, as in a New England town, the town itself appropriated sufficient funds to maintain protection on all the pine within the borders of the town or township.

In much of New England and a limited part of the Lake States, the blister rust problem has become a question of maintaining the gains already made, rather than the initial coverage of any great amount of remaining acreage. The experience developed on the work since 1918 still indicates that in any one stand three successive eradications at intervals of from 5 to 10 years will probably be sufficient to provide protection from the seedling stage to maturity. The time interval varies in different localities, depending upon Ribes conditions and the density of the stand; but it is clear that, in any case in which the tree canopy completely shades the forest floor after the pines are 20 to 30 years old, further Ribes eradication is not likely to be needed in the absence of some unusual disturbances of the soil conditions.

In general, the State foresters and those State officials who are responsible for pest control appear to be alive to the situation. The forests are great public assets of especial value to the localities in which they occur, and the first and most direct responsibility for their protection thus naturally rests on the localities and States concerned, and such localities should strive to assume as much of their own responsibility for forest protection as possible.

BARBERRY ERADICATION DEVELOPMENTS

Grain Rust Situation

In 1935 there occurred the most disastrous grain-rust outbreak that had been suffered in the United States since 1916. Prior to that time serious damage by black stem rust to wheat and other small grains had been occurring at intervals of from three to five years. With the steady reduction in the barberry population, beginning when the barberry eradication campaign was begun in 1918, these losses were steadily and consistently decreasing. Several of the intervening years were suitable for rust

development, but the number of local sources of inoculum had been greatly reduced with the progress of the barberry eradication campaign, and during those years the rust spores arriving from the South reached the Northern States too late to cause extensive damage.

Meanwhile Federal publications, from the time the barberry eradication program was begun, had pointed out clearly the two sources from which northern rust outbreaks could develop: (1) the production of the aecial stage on barberries in the northern localities concerned, and (2) the spread northward from the overwintering red or uredinial stage, in Texas and Mexico. It was further pointed out that under usual conditions the rust spread from the South arrived too late to damage the crops of spring grain in the Northern States seriously.

You will remember that in the spring of 1935 stem rust had survived the winter rather extensively in certain parts of Texas, and that heavy rainfall there in May resulted in an unusually large amount of rust development on winter wheat in that section. In fact, the estimated rust loss for Texas in the spring of 1935 exceeded 1,000,000 bushels of grain. The rust then spread northward into Kansas and Nebraska, and during the latter part of June strong winds, followed by several days of moist, warm weather ideal for development of rust, resulted in an epidemic extending from Mexico northward to the Canadian border. Serious as these losses were, they were confined almost entirely to wheat, and 90 percent of the loss to this crop occurred in Minnesota, North Dakota, and South Dakota, the total damage for the barberry eradication area being estimated at 118,825,000 bushels.

The weather conditions were adapted to rust development throughout the entire grain-growing area from the Allegheny Mountains to the Rockies, but material loss occurred only in the region in which the unusual series of circumstances outlined developed. In the other regions which the spread from the South did not reach, the barberry population had been so greatly reduced that there was little inoculum available and losses were either negligible or very slight. The situation on oats is especially interesting. There was no epidemic on this crop, a condition which appeared to be due to the spring scarcity of the oat strains of stem rust in Texas. Undoubtedly if the 20,000,000 barberry bushes which had been eradicated had still been in existence throughout the area, the epidemic would have extended over a much greater area, and it is possible that the oat crop would have been much more severely damaged.

It is unlikely that the particular series of circumstances which resulted in the 1935 outbreak may occur again in many years. The practice of using more rust-resistant varieties of grain for seed in the States south of the spring-wheat area, and the further reduction of

barberry bushes in the upper Mississippi River Valley, are both tending to diminish the possibilities of such outbreaks in the future.

It has been of considerable interest to note that the heavy losses of 1935 have tended to increase the interest in and favorable sentiment toward barberry eradication in spite of widespread general knowledge that the completion of the eradication program would not necessarily have prevented the 1935 outbreak. This can be noted in various ways, such as in increased correspondence with inquirers as to the barberry work and its importance and an increase in the ease of contact with the property owners who are found to have barberry plants which need to be destroyed. Continuing evidence of the large number of strains of rust which are produced from and in the vicinity of barberry plants, and the difficulty of developing varieties of grain which are resistant to all the various races of rust, are making it increasingly apparent that the extermination of the barberry plant and the breeding of rust-resistant varieties must go hand in hand if agriculture is to solve the grain-rust problem and thereby reach some degree of stability in the production of small grains.

Progress in 1936

The availability of laborers in considerable numbers under the unemployment relief program has made possible a very rapid advance in the progress of the work since 1933. Areas were intensively covered which would have taken eight to eleven years to reach at the rate of progress of 1932 and previously. Such a delay, of course, would have further complicated the control problem by allowing natural spread to continue. The principal development in the original thirteen States has been the finding of numerous barberry plants in out-of-the-way locations in areas in which it had previously been thought unnecessary to make an intensive foot-by-foot survey. This has been particularly true in Michigan and Ohio. In Michigan 480 men have been employed and about 360 in Ohio during the past summer. Between January 1 and December 31, 1936, these employees located 301,234 barberries in Michigan and 234,017 in Ohio. It is clear that the work, especially in these States, is going to take longer and involve intensive surveys of greater areas than was anticipated.

This same thing is true, although to a somewhat less extent, in several adjoining States. During the same period about 300 employees in each State located 10,804 barberries in Illinois, 17,848 in Indiana, 15,993 in Iowa, 10,629 in Minnesota, and 33,968 in Wisconsin. While these figures look very small in comparison with the million or more barberries per year which were being turned up in some of these States several years ago, they still indicate that the problem is far from completion, especially since the areas covered during this past season and for several previous years will need resurveying once or twice more after the dormant seeds in the ground have had time to germinate.

In five of the barberry eradication States west of this central Mississippi Valley area the program has reached the clean-up stage. Less than 700 barberries have been found during the past calendar year in each of the States of Wyoming, South Dakota, Nebraska, and Montana. In North Dakota a somewhat greater number have been turned up, namely, 4,100.

The question of how relief labor could advantageously be employed, especially in these western areas where barberries are becoming scarce, at first was a somewhat puzzling problem. As most of you know, the emergency regulations require that 90 percent of all the persons employed under an emergency allotment must come from relief rolls. In other words, we could arrange for the appointment of only one experienced supervisor for each 9 or more relief laborers. This problem has largely been solved by two developments; first, our being able to pick out one or two reasonably satisfactory crew foremen out of every 10 relief employees certified to us by the relief agencies and, second, by the development of a modification of the former survey procedure.

Usually we try not to have more than five or six men in a truck or car in this survey work, but there are occasions in which it is necessary to use more. In any event, in areas where woodlots are scarce and the ground accordingly can be covered rapidly, the crew leader will send one man along one series of fence rows, another along another series, and possibly several into some woodlot or stream-bed in the distance, so that by the time he reaches the farmhouse he has only one or two laborers with him. The latter are assigned to make an inspection of shrubbery and woodlots surrounding the house and barns. The property owners in most cases have been previously informed of the intended survey by the supervisor, in person or by letter. Under this system it is possible to avoid the objectionable feature of men in large groups tending to duplicate each other's work, thus provoking unfavorable comment.

The emergency funds made available for expansion of the stem rust control work in 1933 may be summarized as follows:

Total amount of funds received through the P.W.A.	$750,000
Total funds received through the C.W.A.	67,663
Total funds allotted from the Emergency Relief Appropriation Acts of 1935 and 1936 to date	2,775,500
Grand total	$3,593,163

While laborers were used throughout the winter of 1935-36 in making city surveys and for eradication work in the larger areas of infestation, peak employment for the season was not reached until May. Since then an average of 4,000 security wage earners have been employed in the 17 States,

with the result that approximately 49,253 square miles of area were covered in 1936 in the thirteen States comprising the original control area and 6,700 square miles in the four new States. A total of more than 68,500,000 barberry bushes were destroyed in 1936 on 11,512 different properties, 2,197,000 of which were located on 6,158 properties in the group of States where control work has been under way since 1918.

New States and Problems

The results of barberry eradication in the thirteen original grain-growing States in reducing the continuous annual drain of rust losses have been so pronounced that four additional States, at their own request, have been included in the program under the emergency allotments. These are Missouri, Pennsylvania, Virginia, and West Virginia. In the latter two States, Berberis canadensis is native and abundant. The work has also been extended into a section of Colorado not previously included, where B. fendleri is native and grows wild in the woods and valleys along the edges of the grain fields. The problem of destroying large patches and areas of native species has introduced a new feature into the problem, since the program has heretofore been confined largely to the destruction of the introduced B. vulgaris that had widely escaped from cultivation. As a result of the attack on these native species, more than 18,594,000 barberries were killed in West Virginia during the calendar year 1936 and 44,961,000 in Virginia. Also, 1,656,800 of the native species (B. fendleri) were destroyed in Colorado.

The barberry population of Missouri is not proving as great as in some of the other States in which initial work is being done, as only 8,804 were found in 1936. In Pennsylvania, however, where B. vulgaris has been permitted to escape from cultivation during the many generations since the original settlement of that State, 2,788,690 bushes and seedlings have been destroyed. The benefits of this work have already been especially notable on the oat crop which, in localities covered in 1935, escaped serious damage from rust in 1936 for the first time in many years.

Barberry eradication is largely accomplished by the use of common rock salt. This is used in such quantities that 3,929 tons were used during the calendar year 1936. The dense patches of native barberry in Colorado and in the grain-growing valleys of the Allegheny Mountains has made it desirable to look for less bulky chemicals than salt. In the case of B. fendleri in southern Colorado, for example, the solid masses of this plant require large quantities of salt per square rod to result in complete kill. All barberries sprout rather easily from the roots, but this western species is particularly prolific in that respect, and a multitude of sprouts develop the year following digging. Among the new chemicals tried, Atlacide applied as a spray and at the same time as a soil drench has proved particularly effective. Since the latter part of August, 20

relief laborers have been engaged in using this material in Colorado, operating knapsack sprayers. They use 8 pounds of Atlacide in 5 gallons of water to each square rod. Tests are also being made with salt in solution, using it as a soil drench, and the preliminary results indicate that possibly the dosage of salt when used in this manner can be reduced.

Rust Susceptibility Studies

Further studies on the susceptibility of various species of cultivated barberries have been continued, and also studies have been made of the ecology of the barberry for the purpose of obtaining a better understanding of the natural increase in the field. Several species which have heretofore been considered of doubtful classification have been placed in the proper class with respect to rust reaction. Approximately 160 species are now growing in the experimental plots in the Foreign Plant Introduction Garden at Bell, Maryland. It was also found that, under natural conditions, most of the barberry seed germinated the first year, although some remained dormant for a time and germinated as much as four to eight years later. It has been definitely established that common salt, generally used for killing the bushes, does not kill seed lying on the ground.

Nursery Inspection

As a result of applications received by the Division of Domestic Plant Quarantine, 23 nurseries were authorized to ship immune species of barberries into protected States. Approximately 4,200 susceptible barberries were eradicated as a result of this inspection and educational work. During the past year 140 specimens of barberry were sent in by State leaders, nursery inspectors, and nurserymen for identification and recommendation.

Educational Work

Largely during periods when considerable numbers of relief laborers are not available for intensive surveys over wide areas, the program has involved educational work in efforts to get as many of the general public and school children to looking for barberries as possible. This work has been systematized and is carried on a county at a time. As a result of work of this kind, more than 3,100 individuals have reported barberry locations, and in many instances the survey of the property and its environs has resulted in the finding of thousands of plants. Work of this type has been somewhat reduced during the past several years of intensive survey, but it is planned that further expansion of it will again be made in the States where it appears to be needed and desirable, whenever opportunity arises and where adequate amounts of relief labor for intensive surveys are not available. (December 30, 1936).

CONTROL OF PHONY PEACH DISEASE

By E. M. Gaddis, Principal Plant Quarantine Administrator, Division of Domestic Plant Quarantines, Bureau of Entomology and Plant Quarantine.

Early History and Progress of the Disease

About 50 years ago a few dwarfed peach trees were observed near Marshallville, Georgia. The trees were called "ponies" because of their small size and were thought to be a new variety. However, the number of trees showing the dwarfing tendency continued to increase, and growers finally came to regard "ponies", or "phonies" as they were later called, as diseased trees. By 1915 the growers became alarmed because of the continued spread of the disease, and assistance was requested from the United States Department of Agriculture.

In 1921 a Federal peach disease laboratory was established at Fort Valley, Georgia, and the disease became the subject of research activities which have continued to date. In 1928, after repeated experimental work, the disease was found to be caused by a root-borne virus.

Distribution of the Disease

Prior to July 1, 1935, the phony peach disease has been found in Texas, Oklahoma, Louisiana, Missouri, Arkansas, Illinois, Tennessee, Mississippi, Alabama, Florida, Georgia, North Carolina, and South Carolina. Since that date infections have been found in Kentucky, Maryland, Indiana, and Pennsylvania. The infected counties are shown in the tabular statement (page 38).

Allotments for Control Activities

In 1929 the first Federal appropriation for the control of phony peach disease became available and cooperative activities with the affected States were started. This work is still in progress, and since August 1935 the regular annual appropriations have been supplemented by fund allotted under the Emergency Relief Appropriation Acts.

Control and Eradication Program

The control and eradication program, which is based on the fact that the disease can apparently be artificially disseminated only through the medium of shipments of infected nursery or root stock, and that its natural spread is relatively slow and local in scope, embraces the following functions:

1. Nursery sanitation. Eradication of diseased trees from the environs of all commercial nurseries in the affected States, thus preventing further long-distance artificial spread of the disease.

2. Annual surveys in States, bordering on the infected region, for the purpose of locating and eradicating any incipient infections; also thorough inspection in the known lightly infected area and eradication of diseased trees therein.

3. Concentrated eradication in and adjacent to the commercial orchards of the generally infected Gulf Coast States.

During the past season the environs of 422 nurseries in the infected States were thoroughly inspected and 104 of them were found to be exposed to the disease. Through concerted Federal and State effort all infected trees around all but one of these nursery properties were removed at the time of inspection or shortly thereafter.

During the past field season approximately 150 Federal and 50 State inspectors were employed. Surveys were carried on in every peach-growing State east and northeast of and including Texas and Arkansas, with the exception of Michigan, New York, and the New England States, and over 21,000,000 peach trees were inspected on 196,344 properties in 550 counties in 20 States; 156,977 infected trees were found, of which 146,072 were removed. All known diseased trees have been eradicated from nine States, namely, Arkansas, Illinois, Indiana, Louisiana, Maryland, Mississippi, Missouri, North Carolina, and Pennsylvania. Diseased trees to the number of 10,905 still remain to be removed from six States, namely, Alabama, Georgia, Kentucky, South Carolina, Tennessee, and Texas, and 10,422 of these trees are in Georgia. Before the winter season is over, it is believed, all known infected trees will be removed from all States except Georgia.

Surveys of the past season included 123 counties not previously inspected. Phony peach was found for the first time in one county each in Indiana and Pennsylvania. It was found for the first time in more than 50 counties in 12 of the States where the disease had previously existed. The progress of the control work is indicated by the fact that in 38 of the counties in which the disease previously existed no infection was found.

From August 1935 to December 31, 1936, approximately 52,000,000 abandoned and escaped peach trees have been removed from nearly 122,000 properties in 11 infected States. During this period the daily employment of relief labor under emergency relief funds has ranged from 1,200 to over 3,000 men.

Present Status of Activities Against Phony Peach Disease

The program has now resulted in the accomplishment of economic control of the disease even in the heavily infected areas, and if the present program can be continued, it is not unreasonable to expect ultimate eradication. (January 22, 1937).

Phony Peach Disease

Counties in which the disease was found in the field season of 1936, and in previous years, as shown by the annual report of the calendar year 1936, by E. A. Cavanagh, Project Leader.

Alabama

*Autauga	Choctaw	*Escambia	Lowndes	Pickens
Barbour	Colbert	Geneva	*Macon	Pike
*Bibb	*Conecuh	Hale	Madison	Randolph
Bullock	*Coosa	Henry	Marengo	Shelby
Butler	Covington	Houston	Marshall	Sumter
*Calhoun	*Cullman	Jackson	Monroe	Talladega
*Chambers	Dallas	*Jefferson	*Montgomery	*Tallapoosa
Cherokee	DeKalb	*Lee	*Perry	*Tuscaloosa
*Chilton	*Elmore			

Arkansas

*Arkansas	*Craighead	*Howard	*Miller	*Saint Francis
*Ashley	Crittenden	Jefferson	*Nevada	Saline
*Bradley	*Cross	*Johnson	*Ouachita	Sebastian
*Chicot	*Desha	*Lafayette	*Phillips	*Sevier
Clark	*Drew	Lee	*Pike	*Union
Clay	Grant	*Lincoln	*Poinsett	White
*Columbia	*Greene	*Little River	Pope	Woodruff
Conway	*Hempstead	Lonoke	Pulaski	

Florida

Baker	Gadsden	Jackson	Leon	Ray
Columbia	Holmes	Jefferson	Madison	Suwanee

* Infected in field season 1936.

Georgia

Baldwin	Crisp	*Berrien	*Monroe	Talliaferro
Banks	*Dade	*Harris	*Morgan	*Taylor
*Barrow	*DeKalb	*Hart	*Murray	Telfair
*Bartow	Dodge	*Heard	*Muscogee	Terrell
Ben Hill	*Dooly	*Henry	*Newton	Tift
*Bibb	*Dougherty	*Houston	Oconee	*Troup
*Bleckley	Douglas	Irwin	*Oglethorpe	Turner
Butts	Fannin	*Jackson	Paulding	*Twiggs
Campbell	*Fayette	*Jasper	*Peach	*Upson
*Carroll	*Floyd	*Jones	*Pike	*Walker
*Catoosa	Franklin	*Lamar	*Polk	Walton
*Chattooga	*Fulton	Laurens	*Pulaski	Warren
Cherokee	Glascock	*Lee	*Putnam	*Washington
*Clarke	Gordon	Lincoln	Randolph	*Webster
*Clayton	Grady	*Lumpkin	*Richmond	Wheeler
*Cobb	Greene	*McDuffie	*Schley	White
Coffee	*Gwinnett	*Macon	*Spalding	*Whitfield
*Columbia	*Habersham	Madison	*Stewart	Wilcox
*Coweta	Hall	*Meriwether	*Sumter	Wilkes
*Crawford	*Hancock	Milton	*Talbot	

Illinois

*Alexander	*Jackson	*Johnson	*Pulaski	*Washington
*Franklin	*Jasper	*Marion	Richland	*Williamson
*Gallatin	*Jefferson	*Massac	*Union	

Indiana

*Gibson

Kentucky

Bullitt	Henderson	*McCracken	Union	Webster
Graves				

Louisiana

Avoyelles	*East Carroll	*Lincoln	Rapides	*Union
*Bienville	Evangeline	*Madison	Red River	*Webster
*Bossier	Franklin	*Morehouse	*Richland	*West Carroll
*Caddo	Grant	Natchitoches	Saint Tammany	Winn
*Claiborne	*Jackson	*Ouachita		

* Infected in field season 1936.

Maryland

Washington Worcester

Mississippi

*Alcorn	Harrison	*Lincoln	*Pearl River	Walthall
Attala	*Hinds	Lowndes	*Prentiss	Warren
*Benton	Homes	Madison	Simpson	Washington
Calhoun	Jasper	*Marshall	Sunflower	Wayne
Clarke	Jones	Monroe	*Tate	Webster
Coahoma	Lamar	Montgomery	*Tippah	Wilkinson
Covington	Lauderdale	*Newton	*Tishomingo	Winston
*DeSoto	Leflore	*Oktibbeha	*Union	

Missouri

*Bollinger	*Dunklin	*Madison	*Pemiscot	*Saint Francois
*Butler	*Franklin	*Mississippi	*Perry	*Scott
*Cape Girardeau	Gasconade	*New Madrid	*Sainte Genevieve	*Stoddard

North Carolina

*Anson	*Cleveland	*Mecklenburg	Richmond	*Stanly
Caldwell	*Gaston	Montgomery	*Robeson	*Wake
Catawba	Iredell	Moore	*Rutherford	

Oklahoma

Bryan

Pennsylvania

*Berks

South Carolina

*Aiken	Charleston	*Edgefield	*Laurens	*Spartanburg
*Anderson	*Chester	*Florence	*Newberry	Sumter
Bamberg	*Chesterfield	*Greenville	Orangeburg	*Union
*Barnwell	*Colleton	*Greenwood	*Richland	*York
Calhoun	*Darlington	Hampton	*Saluda	

* Infected in field season 1936.

Tennessee

Anderson	*Dickson	*Hardeman	*McNairy	*Rhea
*Bedford	*Dyer	*Hardin	*Marion	Roane
Bledsoe	*Fayette	Knox	Meigs	*Rutherford
*Bradley	*Franklin	*Lauderdale	*Polk	*Shelby
*Davidson	*Gibson	*Lawrence	*Putnam	*Warren
*DeKalb	*Hamilton	*Lincoln		

Texas

Anderson	*Comal	Henderson	*McLennan	Shelby
*Angelina	*Comanche	Hood	Medina	*Smith
Atascosa	Dallas	Hopkins	Milam	Tarrant
*Bexar	Denton	Houston	Nacogdoches	Titus
*Bowie	Ellis	Hunt	Palo Pinto	Travis
Brazos	*Erath	Jasper	Parker	Upshur
*Brown	Fayette	Kaufman	Robertson	Van Zandt
Cass	Franklin	Kendall	Rusk	Washington
*Cherokee	Gillespie	*Kerr	San Augustine	Wichita
Collin	Gregg	Lamar	*San Saba	Wood
Collingsworth	Hays	*Limestone		

Of the 227 counties in which the disease was found in 1936, more than 50 were found infected for the first time.

CITRUS CANKER ERADICATION

By B. M. Gaddis, Bureau of Entomology and Plant Quarantine.

Introduction of the Disease into the United States

Citrus canker (caused by Bacterium citri), a very infectious and destructive bacterial disease of citrus, was apparently introduced from Japan on Citrus trifoliata rootstock in 1911, and during subsequent years it became established in seven States embracing the Gulf Coast citrus-producing area from Florida to Texas, inclusive.

Results of Early Eradication Activities

As a result of Federal-State cooperative activities, eradication of the disease was apparently accomplished prior to 1928 in all infected States except in Louisiana and Texas, where it has persisted in the areas in which Satsuma orange production was undertaken on an extensive scale about 25 years ago.

* Infected in field season 1936.

Results of Eradication Activities Since 1921

From 1921 to 1934, partly owing to the inadequacy of the inspection force, only 32 infected properties were found in Texas, and these were in places where the disease had previously existed and in which it was recurring.

Under a reorganization and expansion of personnel, made possible by supplemental emergency relief funds, 54 infected properties previously undiscovered and of long standing were located in Texas and Louisiana during 1935 and the first 9 months of 1936, or 19 more infected properties than were found during the preceding 13 years. These comprised over 900 trees in 4 parishes in Louisiana, and over 1,900 trees in 4 counties in Texas. During the past two years the disease has been found in Calcasieu, Lafourche, St. Charles, and Terrebonne Parishes in Louisiana, and in Brazoria, Galveston, Harris, and Jefferson Counties in Texas.

With the allotment from emergency relief funds it was possible to carry on such intensive inspection activities that the entire citrus-producing areas of Texas and Louisiana have been scouted, and it is believed that all infected areas have been located.

The inspection work has been supplemented by the eradication of more than 13,600,000 worthless, escaped, or abandoned citrus trees during the period from July 1, 1935, to December 31, 1936, thus removing a possible source from which the disease might eventually reach the commercial citrus-producing areas.

It was considered desirable to eradicate not only canker-infected plants but to destroy insofar as possible all hosts of the disease in the noncommercial infected areas in which large numbers of escaped *Citrus trifoliata* plants were growing wild in dense junglelike swamps and woodlands, many of which were found to be infected with canker.

Intensive inspection revealed the presence of citrus on 2,283 properties in the four infected Texas counties of Galveston, Brazoria, Harris, and Jefferson. All of these properties except 43 have been freed of citrus plants. At the present time the removal of citrus plants has been accomplished on over 98 percent of all citrus-growing properties in the known infected areas of Texas. The program, therefore, is aimed at the elimination insofar as possible of all worthless hosts of the disease outside the commercial areas.

Inspection and eradication activities were extended during 1936 to Alabama and Mississippi, where the disease is known to have existed. To date no infection has been found; however, approximately 2,000,000 worthless host plants have been destroyed.

Use of Autogiro in Eradication of Citrus Canker

Incidental to completion of eradication activities in Louisiana, it was considered advisable to survey several hundred wooded islands, or moats as they are sometimes called, in the extensive marshland areas in the southern portion of the State, since it was known that citrus plants existed on some of these moats. The task was one of some concern, especially in view of the inaccessibility, either by boat or land, to many such sites. The problem was, however, successfully solved by the use of an autogiro loaned by the Dutch elm disease project.

The autogiro was used in scouting over this extensive swamp area at a time when citrus trees were in flower and therefore easily distinguished from other vegetation. Approximately 600 such trees were found on 24 of the moats. Ground crews were sent to the recorded locations to inspect carefully for infection, and on one such area, which could be reached by boat and mud scow only, rather heavy canker infection, which had apparently existed for many years, was found and destroyed. This is an excellent illustration of the value of the autogiro in plant-disease-eradication work.

Present Status of Eradication Activities

Accomplishments of the activity in which the affected States have cooperated indicate that the use of emergency relief funds has marked the difference between eradication at an early date and a prolonged program.

In order to perpetuate the achievements of the emergency program and to complete eradication of citrus canker, it will be necessary to recheck the sites from which trees have been removed, to destroy seedlings and sprouts which may appear thereafter, and to reinspect the remaining citrus plantings in the vicinity of old infections. All such sites are accurately recorded and mapped for the purpose of simplifying and expediting economic and thorough reinspections. (January 22, 1937).

Citrus Canker

Counties in which the disease has been found in the field season of 1936 and the previous years, as shown by the summary of the campaign dated November 24, 1933, and subsequent records.

States	Years During Which Infections Were Found	Counties		
Alabama	1916 - 1923	Baldwin	Mobile	
		Escambia	Washington	
Florida	1914 - 1927	Baker	Hardee	Palm Beach
		Bay	Highlands	Pasco
		Brevard	Hillsborough	Pinellas
		Broward	Indian River	Santa Rosa
		Dade	Jefferson	Seminole
		De Soto	Lake	St. Lucie
		Duval	Lee	St. Johns
		Escambia	Marion	Suwannee
		Flagler	Okaloosa	Walton
		Glades		
Georgia	1916 - 1917	Appling	Echols	Randolph
		Berrien	Glynn	Terrell
		Brooks	Grady	Thomas
		Bryan	Irwin	Ware
		Decatur	Lowndes	Wayne
Louisiana	1916 - 1936	Acadia	Jefferson Davis	St. James
		Ascension	Lafayette	St. John
		Assumption	*Lafourche	St. Tammany
		*Calcasieu	Orleans	Tangipahoa
		Iberia	Plaquemines	*Terrebonne
		Jefferson	St. Bernard	Vermilion
			*St. Charles	St. Landry
Mississippi	1917 - 1918	George	Jackson	
		Harrison	Stone	
South Carolina	1916	Charleston		
Texas	1916 - 1936	Bee	Fort Bend	Kleberg
		*Brazoria	*Galveston	Matagorda
		Brooks	*Harris	Nueces
		Cameron	Hidalgo	Orange
		Chambers	Jackson	San Patricio
		Colorado	*Jefferson	Victoria
		Duval	Jim Wells	Webb

* Infections found during the years 1935 and 1936.

ERADICATION OF THE PEACH MOSAIC DISEASE

By B. M. Gaddis, Bureau of Entomology and Plant Quarantine.

Discovery of the Disease and Present Distribution

Peach mosaic, the newest of the five major virus diseases of peach, was first observed at Brownwood, Texas, in 1931 by Federal phony peach inspectors and identified by Dr. Lee M. Hutchins, of the Bureau of Plant Industry, as a previously unknown virus disease. In the summer of 1934 the disease was also reported from Colorado, where it had apparently been established for 4 or 5 years. It is now known to be present also in Utah, California, Arizona, and New Mexico. There are 39 infected counties in these 6 southwestern States. These counties are listed in a supplemental tabular statement (page 46).

Nature of the Disease

Peach mosaic is an infectious virus disease which may be transmitted by budwood or by patch-bark grafts from either twig or root bark. The incubation period is apparently less than 12 months, and the natural spread is very rapid and generally occurs in colony formation.

Progress of Survey and Eradication Activities

Eradication was begun by Colorado State authorities early in 1935, and in August of that year funds from the Emergency Relief Appropriation Act were secured to conduct an eradication program in Colorado and to make surveys in other nearby States. In 1936, under additional allotments from emergency relief funds, the eradication program was extended to include California, Texas, and Utah.

Intensive cooperative surveys carried on in the known infected States and in bordering States in 1935 and 1936 resulted in the inspection of over 4,000,000 trees on 17,000 properties in 171 counties.

The peach mosaic disease was found to be present in 3 counties in California, 1 in Arizona, 10 in New Mexico, 20 in Texas, 2 in Utah, and 3 in Colorado. No peach mosaic disease was found in Iowa, Kansas, or Nebraska.

The inspection and eradication program is being carried on under Federal supervision in cooperation with State pest-control officials. During the field season of 1936, 47,713 mosaic-infected peach trees were found in the infected States. All diseased trees have been removed in Colorado and Utah, and removal of such trees is now under way in California and Texas, and the work will be extended to Arizona and New Mexico in the spring of 1937.

The disease was discovered in California in 1933, but was not determined as "mosaic" until the spring of 1936. The work of approximately 75 inspectors during July to November of the past year revealed infection in the counties of San Diego, Riverside, and San Bernardino. The disease was found to be especially concentrated in the peach-growing areas of Riverside and San Bernardino Counties, where it centered around Redlands and Beaumont. Inspection revealed a total of 29,447 infected trees on 835 properties.

Present Status of Eradication Activities

The project has a rather favorable status at present. However, in view of the incubation period of the disease, there still exist infected trees on which symptoms will not be visible at least until next spring. In order to carry this program through to a point which will protect accomplishments to date, it will, therefore, be necessary to reinspect all known infected properties next season and to continue intensive surveys in the States in which infection is known to exist, as well as in adjoining States, in order that information relative to the spread of the disease may be known and eradication may be accomplished. Under a continued program on this basis, it is not unreasonable to expect ultimate eradication of the peach mosaic disease. (January 22, 1937).

Peach Mosaic

States and counties found to be infected, 1931 to 1936. All these counties were found infected in surveys in the field season 1936.

Arizona

Coconino

California

Riverside
San Bernardino
San Diego

Colorado

Garfield
Mesa
Montezuma

New Mexico

Bernalillo
Dona Ana
Lincoln
Otero
Rio Arriba
Sandoval
Santa Fe
Sierra
Socorro
Valencia

Texas

Bexar
Bowie
Brown
Callahan
Childress
Comanche
Eastland
El Paso
Fayette
Grayson
Kerr
Limestone
Mills
Palo Pinto
San Saba
Smith
Stephens
Wheeler
Wichita
Wilbarger

Utah

Grand
Washington